

March 9, 1937.

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2,072,944

AERATOR

Filed Dec. 21, 1934

2 Sheets-Sheet 1

*Fig. 1.*

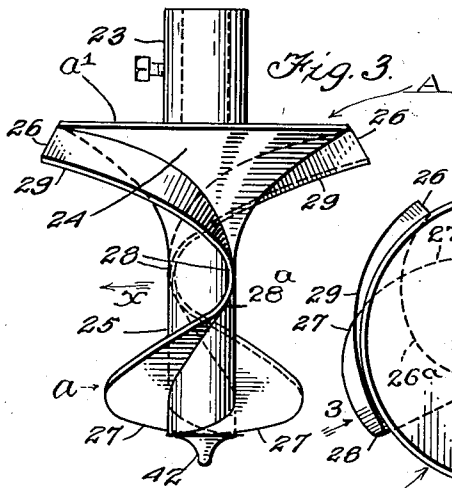
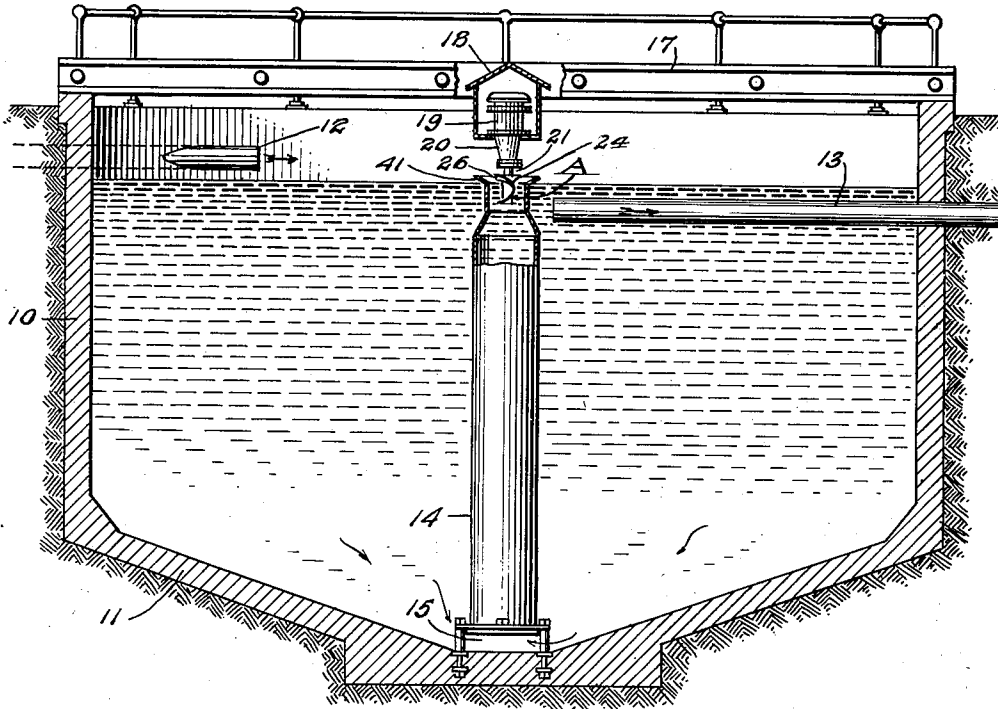


*Fig. 4.*

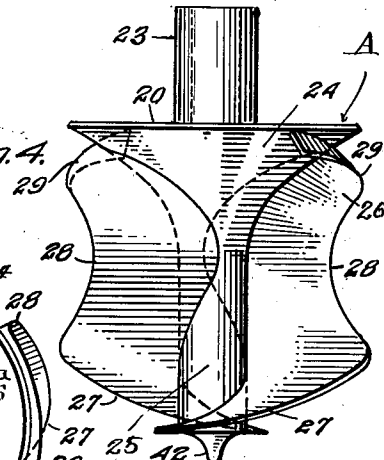
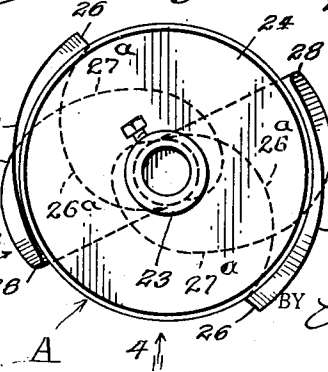


*Fig. 5.*



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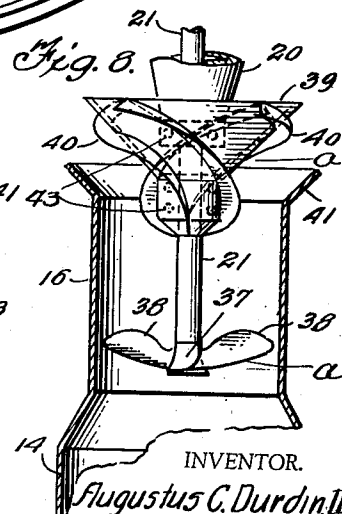
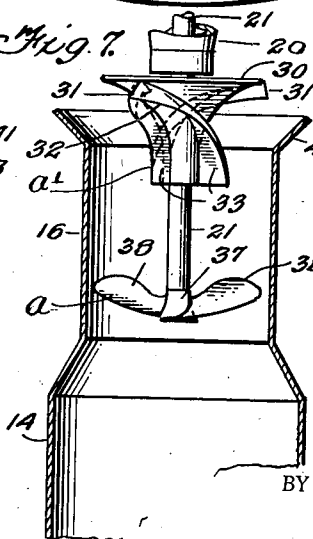
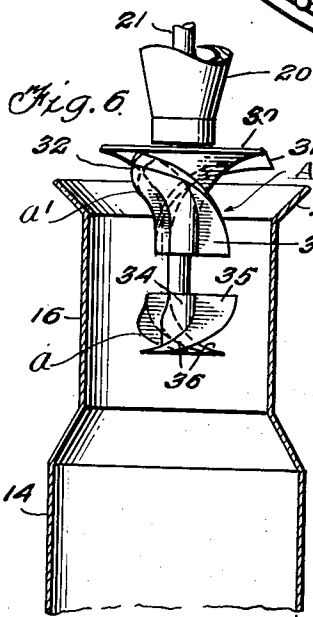
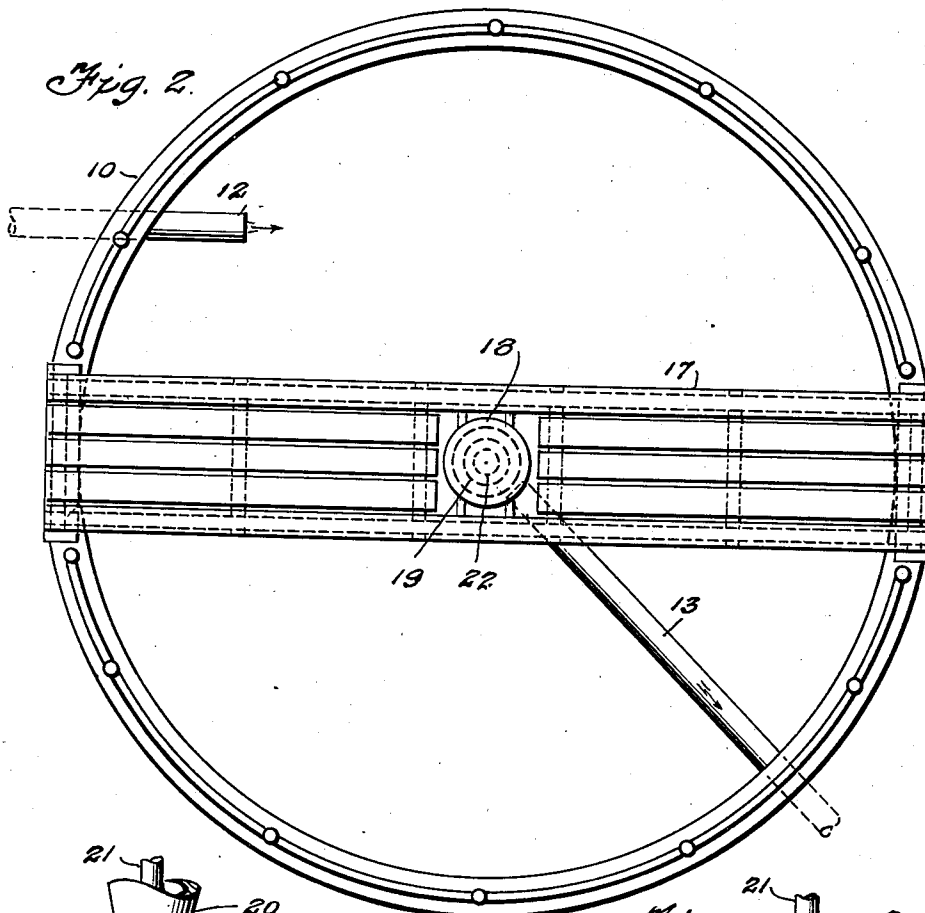
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2 Sheets-Sheet 2

Fig. 2.



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## UNITED STATES PATENT OFFICE

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## AERATOR

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corporation of Illinois

Application December 21, 1934, Serial No. 758,631

12 Claims. (Cl. 210—8)

This invention relates to aerators and its principal object is to provide means for impregnating liquids with an abundant supply of air or other gas. In its present form, the aerator has been shown in connection with a sewage treatment plant, but it is to be understood that its use is not limited thereto, as it may be employed in any situation where liquids are to be impregnated with air or other gases.

Another object is to provide an aerator having means for propelling the liquid to be treated, in combination with mixing means, operating to supply abundant quantities of air to the liquid propelled against it by the propeller. Another object is to provide an aerator in which the liquid propelling means and the mixing means may be formed as a single unit or may be made separate from each other, and in which the propelling means and the mixing means may rotate together or the mixing means may rotate independently of the propelling means or may be mounted against rotation.

Other objects and advantages will appear in the course of this specification and with said objects and advantages in view, this invention consists in the several novel features hereinafter fully set forth and claimed.

The invention is clearly illustrated in the drawings accompanying this specification, in which:

Fig. 1 is a vertical section through a sewage treatment tank equipped with an aerator embodying the preferred form of the invention;

Fig. 2 is a plan of the parts seen in Fig. 1;

Fig. 3 is a detail side elevation of the preferred form of aerator, looking in the direction of the arrow 3 in Fig. 5;

Fig. 4 is a side elevation of the aerator, seen in Fig. 3, looking in the direction of the arrow 4 in Fig. 5;

Fig. 5 is a plan of the aerator;

Fig. 6 is a side elevation of a slightly modified form of aerator showing the same in connection with a certain conduit, the latter being shown in section;

Fig. 7 is a similar view of a second modified form and

Fig. 8 is a similar view of a third modification. Referring to said drawings, which illustrate the application of the aerator to a sewage treatment plant, and referring first to Figs. 1 to 5 inclusive, the reference character 10 designates an aerating tank, usually provided with a hopper like bottom 11. A sewage inlet pipe 12 enters the tank adjacent its upper end and supplies the sewage, to be treated, in a constant or intermittent flow as

desired. A discharge pipe 13 located slightly below the level of the liquid, contained in the tank, permits the treated sewage to be withdrawn from the tank. The liquid level in the tank may be maintained by regulating the water level in the chamber or tank into which the discharge pipe 13 empties.

An upright conduit 14 is located in the center of the tank, which is usually made circular, and the lower end of the conduit is supported in a predetermined spaced relation to the bottom of the tank to form a passage 15 through which the liquid, being treated, rises in the conduit 14. Desirably the area of the passage 15 approximately equals the cross-sectional area of the conduit 14. This arrangement causes a velocity of the moving liquid, in proximity to the passage 15, to be such that no settling will occur at the low point of the tank, to permit septicization of the sludge. The conduit 14 is preferably, although not necessarily, formed with a constricted throat 16 near its upper end, through which the velocity of the liquid is increased when the apparatus is in operation.

A bridge or truss structure 17 extends across the top of the tank over the conduit, and supported by said bridge is a housing 18 in which is enclosed a motor 19 or equivalent prime mover for rotating the aerator A. A conical bearing bracket 20 depends from the motor frame and contains anti-friction bearings for a shaft 21, which connects the aerator with the motor.

The aerator forming the subject matter of this specification extends into the throat of the conduit 14, being axially disposed with respect thereto, and comprises a lower propelling element *a*, and an upper mixing member *a*<sup>1</sup>. The propelling element and mixing member of the preferred form are shown as composed of one piece. The aerator is provided with a hub 23 by means of which it is mounted upon the shaft 21 and this also provides for vertical adjustment of the aerator with respect to the level of the liquid in the tank. The propelling element *a* preferably takes the form of a screw propeller or conveyor, the blades 27 of which project from a cylindrical body portion 25 and are wound around said body portion from the lower end thereof along a sloping plane for some distance and then are curved upward sharply as at 28<sup>a</sup> to the place indicated by the reference character 28 in Fig. 3. The marginal outer edges of the blades 27 are somewhat in the nature of spiral or involute curves (see dotted lines 27<sup>a</sup> in Fig. 5) commencing at the circumference of the body portion 25 and progressing

outward radially to their greatest radius which is at the place indicated by the reference character 28. Along the sharply curved parts 28<sup>a</sup> of the blades 27, they extend substantially tangential with respect to the body portion and at this place they act to impart a centrifugal action upon the liquid. Below the sharply curved part 28<sup>a</sup>, the blades 27 act to lift or propel the liquid upward at great velocity, the purpose of which will presently appear.

The mixing member *a*<sup>1</sup>, forms a continuation of the propelling element *a* in the preferred embodiment of the invention and as shown, the mixing member comprises an inverted cone shaped body 24 which merges into the body portion 25 at its lower end, and mixing blades 26 that project from the cone shaped body and form continuations of the propeller blades 27. From the point 28, the blades 26 curve sharply forward in the direction of rotation of the aerator (see arrow *x* in Fig. 3) and then slope upward and forward along the conical surface of the body 24, to the base thereof (see dotted lines 26<sup>a</sup> in Fig. 5) the free edges 29 of the blades 26 being tipped downwardly as is clearly illustrated in Figs. 3 and 4 to form troughs between the conical face of the body 24 and the blades 26. It is also to be observed that the blades 26 diminish in width from the point 28 to the place where the blades terminate at the margin of the base of the cone shaped body 24, the marginal edges thereof being substantially circular (in plan) from the point 28 to their extreme ends. The lower end of the body portion of the aerator may be provided with a tapered tip 42 to provide a streamline flow and prevent eddies. The upper edge of the constricted part of the throat 16 of the conduit is desirably formed with an outwardly flaring portion 41 which gradually reduces the velocity of the liquid passing the aerator.

In actual operation, the conveyor element *a* is more or less submerged in the liquid and the mixing member *a*<sup>1</sup> is disposed above the level of the liquid in the tank.

The aerator is rotated at high speed and in operation the propeller blades 27 lift the liquid in the conduit and propel it upward against the cone shaped body 24 and blades 26. The liquid is propelled upward at a high velocity and is in a turbulent state during its upward travel. The velocity is such that as the liquid strikes the sharply curved parts 28<sup>a</sup> of the blades 26, it continues to move upward between the blades 26 and cone. Air is caught in the troughs between the blades 26 and cone and a partial vacuum is created behind said blades into which air rushes, and since the upwardly moving liquid is in a rolling and turbulent condition, the air is beaten into the liquid in abundant quantities and the liquid is thereby thoroughly aerated. From the point 28 on the blades to their extremities at the base of the cone, a centrifugal action is imparted to the liquid and it is showered back upon the surface of the liquid in the tank. In some instances, a platform (not shown) is provided above the level of the liquid upon which the aerated liquid is thrown and from which it falls into the liquid in the tank. The liquid discharged from the conduit 14 by the aerator is replaced by liquid entering the conduit at its bottom and thus the liquid in the tank is circulated therein from top to bottom.

In the modified form, illustrated in Fig. 6, the two co-operating parts *a*, *a*<sup>1</sup> of the aerator are separated, but are mounted upon the shaft 21.

The cone 30 has the mixing blades 31 secured to or formed thereon and these blades have the entrapping edge portions 32 leading down along inclined planes to the more nearly upright sections 33 thereof. As in the preferred form the blades 31 are wrapped around the cone and incline forward in the direction of rotation toward the top of the cone. The propeller is spaced away from the mixing member and carries the propeller blades 35, which terminate in screw like sections 36 at their lower ends. The conduit 14, as in the preferred form, leads the liquid up from the bottom of the tank and the constricted throat 16 causes an increased velocity in proximity to the aerator.

The operation of this form of the invention is substantially the same as that of the preferred form. The propeller propels the liquid up against the mixer where air is beaten into the liquid as described in connection with the preferred form of the invention.

In the modified form illustrated in Fig. 7, the mixing member *a*<sup>1</sup> is constructed substantially similar to the mixing member *a*<sup>1</sup> shown in Fig. 6, and the propelling element *a* is spaced a considerable distance below the mixing member. Both mixing member and propelling element are mounted on the shaft 21 and rotate therewith. In this form of the invention, the propelling element is somewhat in the nature of a boat propeller having the usual hub 37 and blades 38 carried thereby. The blades are pitched to set up the desired velocity in the water in an upward direction.

In the modified form illustrated in Fig. 8, the cone 39 and blades 40 of the mixing member *a*<sup>1</sup> are of substantially the same construction as that shown in Figs. 6 and 7 and the propelling element *a* is substantially of the same construction as the propeller illustrated in Fig. 7. The propeller is rigidly mounted on the shaft 21 and rotates therewith, but the mixing member may be rotatively mounted upon the shaft 21 as by bearings 43, or it may be stationarily mounted on the bracket 20 as desired. When rotatively mounted on the shaft, the liquid propelled against the blades 40 and cone 39 by the propeller, causes the mixing member to rotate in a reverse direction to that taken by the propeller, but nevertheless a very thorough aeration of the liquid is obtained. The same result is also obtained in cases where the mixing member is held stationary.

The aerator has been found to be particularly efficient in the aeration of sewage, in sewage treatment plants which employ the activated sludge process. As is well understood, in this process, aerobic bacteria are employed, and abundant quantities of oxygen must be supplied to the bacteria. The aerator described, because of its peculiar characteristics, effectively beats air into the sewage in abundant quantities. It is equally adapted for impregnating liquids with other gases in the treatment thereof.

I claim as new and desire to secure by Letters Patent:

1. An aerator, comprising a rotary liquid propelling element, and an opposed liquid deflecting cone having inclined blades thereon extending, in their entirety, along and outwardly from the conical face of the cone.

2. An aerator comprising a rotary liquid propelling element, an opposed conical deflecting member having blades thereon against which the liquid is propelled by the propelling element, and

means connecting said liquid propelling element and deflecting member to rotate in unison.

3. An aerator comprising a rotary screw propeller having inclined propelling blades thereon, with their entering edges at the bottom of the blades and a conical body above said blades having inclined blades disposed along its conical face and directed in opposed relation to the inclined blades of the screw propeller, and spaced therefrom.

4. An aerator comprising a rotary liquid propelling element, a freely rotating conical member having inclined blades thereon extending, in their entirety, along and outwardly from the conical face thereof, said conical member with its blades being disposed opposite to the propelling element and co-operating therewith to impregnate the propelled liquid with air, and separate bearings for the liquid propelling element and conical member.

5. An aerator comprising a rotary liquid propelling element, and a stationarily mounted conical mixing member having inclined blades thereon extending, in their entirety, along and outwardly from the conical face thereof, said mixing member being disposed opposite to the propelling element and co-operating therewith to impregnate the propelled liquid with air.

6. An aerator comprising a rotary body formed with a cylindrical lower portion and an inverted cone like upper portion, propeller blades wound helically around the cylindrical portion of the body, and mixing blades wound helically around the cone like portion in opposed relation to the propeller blades and merging into the same in sharply curved portions.

7. An aerator comprising an inverted cone shaped body terminating at its apex portion in a cylindrical portion, mixing blades wound around the conical portion of the body, and reversely directed propelling blades wound around the cylindrical portion, the marginal edges of the mixing blades being approximately concentric with the axis of the cone, and the marginal edges of the propelling blades being spirally inclined toward the body portion.

8. An aerator comprising an inverted cone shaped body terminating at its apex portion in a cylindrical portion, downwardly tipped mixing blades wound around the conical portion of the body, and reversely directed propelling blades wound around the cylindrical portion, the marginal edges of the mixing blades being approximately concentric with the axis of the cone, and the marginal edges of the propelling blades being spirally inclined toward the body portion.

9. An aerator comprising an inverted cone shaped body terminating at its apex portion in a cylindrical portion, downwardly tipped mixing blades wound around the conical portion of the body, and reversely directed propelling blades wound around the cylindrical portion.

10. An aerator comprising an inverted cone shaped body terminating at its apex portion in a cylindrical portion, downwardly tipped mixing blades wound around the conical portion of the body, and reversely directed propelling blades wound around the cylindrical portion, and merging into the mixing blades in sharply curved, centrifugally acting portions, the marginal edges of the mixing blades being approximately concentric with the axis of the cone, and the marginal edges of the propelling blades being spirally inclined toward the body portion.

11. An aerator, comprising an upright shaft, a rotary liquid propeller mounted thereon, an opposed conical deflecting member disposed in co-axial alignment with said propeller and having curved blades thereon disposed in the path of liquid propelled by the propeller.

12. An aerator, comprising a rotary liquid propelling element, an opposed conical deflecting member, disposed in co-axial alignment with said propelling element and having blades thereon disposed in the path of liquid propelled by the propelling element, and means connecting said propelling element and deflecting means whereby they rotate together.